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Relationship Between Respiratory Morbidity in Children and the Home Environment

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The relationships between 12 features of the home environment and respiratory morbidity as reported by parents, and as recorded in general practice records, were studied in 185 children aged seven to eight years. Parental reports of wheeze, nocturnal cough and school absence owing to chest trouble were significantly more common among children with a family history of wheeze, and those from damp or mouldy housing. There were associations between coal fires and nocturnal cough and between an open window and wheeze. Multivariate analyses confirmed these associations to be independent of each other, and of the child's sex and seven other features of the home environment, including gas appliances and parental smoking. These same environmental variables were not consistently related to general practice consultations for wheeze or lower respiratory illness. Damp and mouldy housing, coal fires and open bedroom windows should be investigated further as potentially remediable causes of respiratory disease in childhood.

The role of environmental factors in the causation of respiratory morbidity in childhood is poorly understood. Hitherto, interest has focussed on the possible hazards of parental smoking and nitrogen dioxide from gas cookers.[1–4] Respiratory illness is more common among children who live in neighbourhoods classified as urban local authority housing,[5] and there is a widespread conviction that housing in some way influences respiratory health.[6] This paper describes an exploratory study of the association between respiratory morbidity and various aspects of the home environment among seven- to eight-year-old children registered with a Scottish urban general practice serving an area of predominantly local authority housing.

METHOD

In October 1983 a review was made of the general practice records of 198 children born in 1976 and registered with the West Granton Medical Group, Edinburgh, Scotland. This large practice serves one of the most socially deprived areas of the city. Entries in the records with a mention of wheeze, rhonchi or 'bronchospasm' were termed wheezing episodes, and those with a record of cough, wheeze or breathlessness, or auscultatory signs in the chest, were termed lower respiratory tract illnesses. Coryza, pharyngitis and otitis media were excluded, but an isolated symptom of cough was considered as a lower respiratory illness.

In January 1984 a postal questionnaire was sent to the parents of the same 198 children, enquiring how many nights the child had been kept awake by coughing during the autumn term 1983, and how many days the child had lost from school during the same term owing to chest trouble. These were chosen as readily quantifiable measures of respiratory morbidity that are known to relate to asthma in childhood. The parents were also asked if their child had ever had attacks of wheezing (defined in the questionnaire as breathing making a high-pitched whistling sound) and, if so, whether ther had been any attacks over the past two years. This first questionnaire made no reference to interest in the home environment.

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In April 1984 a further questionnaire was sent to the same parents enquiring about absence from school owing to chest trouble, and about nocturnal coughing and wheezing during the spring term 1984. Additional questions related to features of the family and home environment which were considered to be possible risk factors for respiratory disease in this age group. Twelve features were expressed as binary variables for analysis:

1. Family history of wheeze: any first degree relative who had ever had attacks of wheezing.
2. Family size of four or more: usually resident at the child's home address.
3. Other children in the family: usual residents under 16 years of age.
4. More than one person per room: usual residents, rooms excluding kitchen and bathroom but including living rooms.
5. Other persons sleeping in the child's bedroom.
6. Child's bedroom unheated: usually, over the past six months (winter 1983–4).
7. Child's bedroom window left open at night: usually, over the past six months (winter 1983–4).
8. Gas: any unvented gas-fired appliance in the house.
9. Coal: any coal-fired appliance in the house.
10. Parental smoking: any person smoking more than five cigarettes per day while in the house.
11. Damp: positive response to the question; is your home affected by damp?
12. Mould: positive response to the question; is your home affected by mould or fungus?

Univariate analysis was by 2×2 contingency tables. The cross-product ratio (relative odds) was used to express the degree of association and significance levels were assessed by the chi-square test. Multiple logistic regression analysis was carried out using the GLIM statistical package.[7]

RESULTS

Complete questionnaire data was received from the parents of 165 (83%) of the children. The response rates were similar for those with and without a record of wheeze in their general practice notes (89% and 81% respectively), suggesting minimal bias, at least with respect to wheezing. Of these 165 children, 159 (96%) had general practice records complete for the past two years, and 143 (87%) were complete from birth.

Risk Factors in the Home

All but 20 of the 165 children studied lived in local authority housing. Investigation of the associations among the 12 features of the home environment found that damp was significantly more common in homes where coal was burnt ($\chi^2 = 7.32$, 1 df, $P<0.01$), but not in homes using gas ($\chi^2 = 0.56$). No significant association was found between a family history of wheeze and parental smoking or damp housing. Parental smoking was, however, more common in homes affected by damp ($\chi^2 = 7.36$, $P<0.01$). Of the 50 homes in which damp was reported 66% were also said to have mould or fungus, but only two families reported mould in the absence of damp. The local environmental health department had received complaints of damp or mould from only five of these premises, although in all five cases dampness was confirmed after investigation by the department.

Associations with Parental Reports of Symptoms

The parents of 33 children reported that their child had wheezed at some time. Of these, 31 (94%) were reported to have wheezed during the past two years and 21 (64%) during the spring term 1984. Of these 33 children 22 (67%) had attended their general practitioner at some time with wheeze, but only 16 (48%) had done so in the past two years. Furthermore, a wheezing illness was found in the records of 27 children whose parents reported they had never wheezed. The association of parental reports and general practice records of wheeze was therefore not as strong as might have been expected. The association between general practice consultations for lower respiratory illness and reported respiratory morbidity (school absence and nocturnal cough) was similarly weak.

The associations between parental reports of wheeze and the 12 features of the family and home environment were first assessed by univariate analysis (Table 1). Significant associations were noted with a family history of wheeze, an open bedroom window and damp or mould in the house. Multiple logistic regression analysis including the sex of the child and these 12 features as explanatory variables, with stepwise removal

TABLE 1 *Degree of association (expressed as relative odds of morbidity) between wheezing, school absence and nocturnal cough and 12 features of the home environment, based on reporting by parents*

Risk factor	Prevalence (%)	Ever wheezed (20%)[a]	Autumn term 1983	
			School absence (25%)[a]	Nocturnal cough (49%)[a]
Family history of wheeze	48	2.6*	2.6*	2.8*
Family of 4 or more	82	1.0	0.7	1.0
Other children in family	84	1.1	0.6	0.7
More than one person per room	67	1.0	1.1	0.6
Others sleeping in bedroom	58	1.0	1.1	1.4
Bedroom unheated	60	1.5	1.1	1.6
Bedroom window open at night	28	3.6*	2.2	1.3
Gas appliance	69	0.9	0.8	1.0
Coal appliance	14	0.8	1.1	2.7
Parental smoking	75	2.1	2.9*	1.7
Damp	30	2.7*	3.0**	4.0***
Mould	21	3.9**	2.5*	4.8***

[a] Prevalence
*P<0.05, **P<0.01, ***P<0.001

of terms, demonstrated that three factors independently contributed to the risk of wheeze: a family history of wheeze ($\chi^2 = 4.35$, $P<0.05$), an open bedroom window ($\chi^2 = 9.76$, $P<0.01$) and mouldy housing ($\chi^2 = 9.88$, $P<0.01$). Given these factors, an unheated bedroom was of borderline significance ($0.05<P<0.1$).

Absence from school owing to chest trouble during the two terms of the study was reported by the parents of 52 (32%) of the children, with 41 of these absent during the autumn term. Similar associations were found on univariate analysis during each term, suggesting that additional questions about the home environment had not biassed the reported morbidity in the second questionnaire. The data relating to the autumn term 1983 are presented in Table 1. A family history of wheeze, parental smoking and damp or mouldy housing emerged as significant risk factors in univariate analysis. Multiple logistic regression analysis, using school absence during either term as the response variable, and the child's sex and the 12 features of the home environment as explanatory variables, demonstrated independent contributions from a family history of wheeze ($\chi^2 = 10.39$, $P<0.01$) and mould ($\chi^2 = 7.04$, $P<0.01$). When parental report of wheeze was included as a further explanatory variable, only family history remained as an independent risk factor, whereas the effect of wheeze was highly significant ($\chi^2 = 31.4$, $P<0.001$).

The parents of 90 (55%) children reported that, at some time during the spring or autumn term, their child had been kept awake by coughing, 81 of these reporting cough during the autumn term. Again, the associations between environmental factors and reported symptoms were similar for each of the two terms in the study. Nocturnal cough during the autumn term was significantly associated with a family history of wheeze and damp and mouldy housing (Table 1). The association with coal-burning was of borderline significance ($\chi^2 = 3.6$, $0.05<P<0.1$). Multiple logistic regression analysis using nocturnal cough during either term as the response variable, and explanatory variables as before, demonstrated independent contributions from a family history of wheeze ($\chi^2 = 9.93$, $P<0.01$), coal ($\chi^2 = 4.67$, $P<0.05$) and mould ($\chi^2 = 11.89$, $P<0.001$). When wheeze was included as a further explanatory variable, it made an independent contribution ($\chi^2 = 11.73$, $P<0.001$) but family history, coal and mouldy housing remained significant risk factors for nocturnal cough ($P<0.05$ in each case).

In the multiple logistic regression analyses reported above, no significant interactions were found between the contributing factors, although with a population of this size, interaction effects would have to be large to reach statistical significance. Thus, the effect of environmental factors did not differ significantly between children with and without a family history of wheeze.

TABLE 2 *Degree of association (expressed as relative odds of morbidity) between consultations for wheezing illness and lower respiratory illness and 12 features of the home environment, based on general practice records*

Risk factor	Prevalence (%)	Wheezing illness		Lower respiratory tract illness	
		Age 0–5 (any) (22%)[a]	Age 5–7 (any) (13%)[a]	Age 0–5 (3 or more) (39%)[a]	Age 5–7 (any) (53%)[a]
Family history of wheeze	48	2.9*	1.4	2.0	0.9
Family of 4 or more	82	3.0	0.5	1.2	1.2
Other children in family	84	1.7	0.6	0.5	1.2
More than one person per room	67	1.0	0.7	1.0	0.7
Others sleeping in bedroom	58	0.7	0.9	0.8	0.9
Bedroom unheated	60	0.7	1.8	0.7	1.2
Bedroom window open at night	28	1.3	1.9	0.8	1.3
Gas appliance	69	1.8	1.0	0.9	1.2
Coal appliance	14	1.0	3.8	0.4	0.7
Parental smoking	75	3.4*	1.6	1.3	0.8
Damp	30	2.1	1.7	1.2	0.8
Mould	21	2.2	1.5	1.0	1.0

[a] Prevalence
*P<0.05, **P<0.01, ***P<0.001

Associations with General Practice Consultations for Wheezing and Respiratory Illness

The associations between the 12 features of the family and home environment and general practice consultations for wheezing illness and lower respiratory illness at different ages were assessed by univariate analysis (Table 2). Despite the strong associations of certain environmental features with reported morbidity (Table 1), these same features did not, overall, increase the probability of consultation with respiratory illnesses. When consultations for wheeze during the first five years of life were considered separately, there were significant associations with a family history of wheeze and parental smoking (Table 2). Frequent consultations for lower respiratory illness at ages up to four years did not result in a significantly greater probability of consultation with such an illness at age five to seven years ($\chi^2 = 3.0$, $0.05 < P < 0.01$). These observations would suggest that neither current respiratory morbidity nor long-standing patterns of consultation behaviour have a great influence on consultations for respiratory illness at this age.

The lack of overlap between reports of wheeze by parents and in the general practice records was exploited to investigate whether the association of reported morbidity and the home environment was accounted for by biassed symptom reporting (discussed further below). Among the 432 children whose parents denied wheeze, a recorded consultation for wheeze was weakly associated with parental smoking (odds 3.7, $\chi^2 = 3.5$, $0.05 < P < 0.1$) and damp housing (odds 2.5, $\chi^2 = 3.1$, $0.05 < P < 0.1$), suggesting that the association between symptoms and damp housing may not be entirely due to reporting bias.

DISCUSSION

Many of the studies relating respiratory morbidity in childhood to environmental factors have relied upon reports of symptoms or diagnoses by parents. Reporting behaviour by parents may not be independent of the environment, particularly when the latter varies with socioeconomic status or is considered by the lay person to be detrimental to health. In a study of adult respondents, 43% of those living in areas of bad housing associated respiratory symptoms with their housing situation, whereas in areas of good housing only 10% did so.[6] Here, general practice records provided an additional data source against which it was hoped to verify parental reports of cough and wheeze. The correlation between reported morbidity and recorded consultations was not as close as might have been anticipated, and the associations which emerged, often at high levels of statistical significance, between the environment and reported symptoms were not found with general practice consultations for wheeze or lower respiratory tract illness.

This raises the possibility that reporting bias may account for some of the associations

observed. Parents of symptomatic children may be more aware of potentially adverse environmental circumstances or parents who perceive their housing to be unsatisfactory may report symptoms of a different degree of severity than others. The design of the questionnaire survey to some extent guarded against such bias. The first questionnaire made no mention of interest in the home environment, enquiring only about symptoms. These symptoms were, nevertheless related to environmental variables derived from the second questionnaire. Furthermore, comparison of the responses to each questionnaire did not suggest that inclusion of questions about the home influenced reporting behaviour. Also, if reported data were excluded, damp housing was still associated (albeit at borderline significance) with consultations for wheeze. While it is acknowledged that reporting bias cannot be entirely excluded without objective physiological data, it is considered unlikely that the observed associations are entirely artefactual. Some doubt must be cast on the validity of general practice records as indices of lower respiratory morbidity in this age group.

The population studied was not representative of the city as a whole, but, by concentrating on an area of predominantly local authority housing, possible correlations between housing conditions and socioeconomic status were minimized. Furthermore, a number of other aspects of the home environment which might be expected to vary with social status were controlled in the analysis. In this population, highly significant associations emerged between damp and mould in the house and respiratory morbidity in children, at least as reported by their parents. On the grounds of the strength of the association, its consistency for all measures of reported morbidity studied, and its persistence when a number of possible confounding variables are controlled, damp, mouldy housing deserves consideration as a contributing cause of respiratory disease in children up to seven years old. Damp and mould are a common cause of complaint on aesthetic grounds. These potentially remediable conditions affect an estimated 2.5 million dwellings in the UK[8] and one-quarter of Scottish council houses.[9] The possibility that they might be a hazard to health should be more extensively investigated. In this preliminary enquiry, no independent assessment of damp or mould was made, but future studies could objectively assess both relative humidity and the presence of fungal moulds or the prevalence of airborne fungal spores.

Others have reported an association between damp bedroom walls and wheeze in adults[10] and a correlation between relative humidity in the bedroom and respiratory symptoms in children.[11] Dampness encourages the growth of house dust mites, but it is unlikely that they are of aetiological significance in more than a few children with mite-sensitive asthma.[12] Most children who wheeze in early childhood eventually develop atopic reactions on skin-tests to common inhaled allergens,[13] and it is possible that fungal spores from mould may react with sensitized bronchi to cause both cough and wheeze. Exercise is a common precipitating cause of wheeze in the asthmatic child, but the available evidence suggests that a damp environment should have a protective effect.[14]

At the age of seven years, however, few children exhibit atopic skin test reactions,[13] and only half of the children with recent wheeze in this study were said to have attacks precipitated by exercise. Most episodes of wheeze in early childhood are thought to be precipitated by infection, and in at least half of cases a virus can be isolated.[15] It has been suggested that high relative humidity may encourage the transmission of viruses in droplet spray.[16]

The association of an open bedroom window with wheeze, but not with school absence or nocturnal cough, raises the possibility that this is a response by parents to the child's symptoms, rather than a factor of aetiological importance. In view of the likelihood that opening the window would raise the relative humidity of the room, such a response may be inappropriate.[11] The association of coal-fired appliances with cough is based on a small number of coal-fired homes but may warrant further consideration.[10,17] Although unvented gas appliances have been associated with respiratory symptoms in some studies of children of this age,[3] the relative risks quoted are small and might not be detected as significant in a study of this size. The data presented here do not support the hypothesis that greater condensation occurs in homes with gas cookers.[4] Parental smoking emerged as a less significant factor than might have been supposed,[1,2] but the analysis excluded the possibility that either smoking or gas fumes could account for the observed association between damp, mouldy housing and lower respir-

atory morbidity in this sample of primary schoolchildren.

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